

Claims

1. A method for sonication-enhanced digestion of cellular matter, said method comprising:
 - supplying cellular matter comprising microbes to a bioreactor;
 - sonically disrupting said cellular matter; and
 - mixing the cellular matter in the bioreactor for a time sufficient for the cellular matter to be digested by the microbes.
2. The method of claim 1 wherein sonically disrupting said cellular matter comprises supplying sonic energy to a first zone of said bioreactor in the frequency range of about 1 kHz to about 10 kHz.
3. The method of claim 1 wherein sonically disrupting said cellular matter comprises supplying sonic energy to a plurality of zones.
4. The method of claim 3 comprising supplying sonic energy to a first zone in a frequency range of about 1 KHz to about 10 kHz.
5. The method of claim 3 comprising supplying sonic energy to a second zone in a frequency range of about 1 KHz to about 2,000 kHz.
6. The method of claim 1 wherein said mixing of said cellular matter is at about 0.25 rpm to about 5.0 rpm.
7. The method of claim 1 further comprising supplying conditioned microbes to said bioreactor.
8. The method of claim 7 wherein said microbes are acid-forming microbes.
9. The method of claim 7 wherein said microbes are methanogenic microbes.
10. The method of claim 1 wherein a vacuum is provided within the bioreactor.
11. The method of claim 1 further comprising removing biogas produced in said bioreactor.
12. The method of claim 1 further comprising heating of a portion of said bioreactor.

13. The method of claim 1 further comprising supplying a process controller to monitor and modify said sonic disruption and providing said disrupted cellular material for microbial production.
14. The method of claim 1 wherein said cellular matter is manure.
15. The method of claim 1 wherein said cellular matter is lignocellulose.
16. The method of claim 1 wherein said cellular matter is municipal wastes or sludge.
17. The method of claim 1 wherein said cellular matter is industrial wastes or sludge.
18. A method for sonication-enhanced degradation of cellular matter, said method comprising:
 - supplying cellular matter comprising microbes to a first bioreactor; and
 - subjecting said cellular matter to sonic energy in a frequency range of about 1 kHz to about 10 kHz in said first bioreactor.
19. The method of claim 18 further comprising mixing said cellular matter in said first bioreactor.
20. The method of claim 18 wherein said mixing of said cellular matter is at about 0.25 rpm to about 5.0 rpm.
21. The method of claim 18 further comprising supplying a process controller to monitor and modify said sonic disruption.
22. The method of claim 18 wherein said cellular matter is manure.
23. The method of claim 18 wherein said cellular matter is lignocellulose.
24. The method of claim 18 wherein said cellular matter is municipal wastes or sludge.
25. The method of claim 18 wherein said cellular matter is industrial wastes or sludge.
26. The method of claim 18 further comprising supplying said cellular matter from said first bioreactor to a second bioreactor.
27. The method of claim 26 further comprising subjecting said cellular matter to sonic energy in a frequency range of about 1 kHz to about 2,000 kHz.

28. The method of claim 26 further comprising mixing said cellular matter in said bioreactor.
29. The method of claim 28 wherein said mixing of said cellular matter is at about 0.25 rpm to about 5.0 rpm.
30. The method of claim 26 further comprising supplying conditioned microbes to said second bioreactor.
31. The method of claim 30 wherein said microbes are acid-forming microbes.
32. The method of claim 30 wherein said microbes are methanogenic microbes.
33. The method of claim 26 wherein a vacuum is provided within said second bioreactor.
34. The method of claim 26 further comprising removing biogas produced in said second bioreactor.
35. The method of claim 26 further comprising heating of a portion of said bioreactor.
36. The method of claim 26 further comprising supplying a process controller to monitor and modify said sonic disruption and providing said disrupted cellular material for microbial production.
37. A system for sonication-enhanced digestion of cellular matter, said system comprising:
- a bioreactor for cellular matter, said bioreactor having an inlet and an outlet;
 - a sonic energy source operatively connected to said bioreactor; and
 - at least one rotating member operatively connected to said bioreactor;
- wherein cellular matter enters said bioreactor through said inlet, is mixed by said at least one rotating member and is subjected to sonic energy and microbial digestion in said bioreactor.
38. The system of claim 37 wherein said sonic energy source supplies sonic energy to said cellular matter in a first zone of said bioreactor in a frequency range of about 1 kHz to about 10 kHz.

39. The system of claim 37 wherein said sonic energy source supplies sonic energy to said cellular matter in a plurality of zones.
40. The system of claim 39 wherein said sonic energy source supplies sonic energy to said cellular matter in a first zone in a frequency range of about 1 KHz to about 10 kHz.
41. The system of claim 39 wherein said sonic energy source supplies sonic energy to said cellular matter in a second zone in a frequency range of about 1 KHz to about 2,000 kHz.
42. The system of claim 37 wherein said sonic energy source comprises a contact plate operatively connected to said bioreactor, a transducer operatively connected to said contact plate, a wave-form generator operatively connected to said transducer and a power supply operatively connected to said wave-form generator.
43. The system of claim 37 wherein a vacuum is maintained in said bioreactor.
44. The system of claim 37 further comprising microbes supplied to said bioreactor.
45. The system of claim 44 wherein said microbes are acid-forming microbes.
46. The system of claim 44 wherein said microbes are methanogenic microbes.
47. The system of claim 37 wherein the bioreactor has a first end and a second end and wherein said second end is elevated with respect to said first end.
48. The system of claim 37 further comprising a means for heating said a portion of said bioreactor.
49. The system of claim 37 further comprising a gas exhaust valve operatively connected to said bioreactor.
50. The system of claim 37 further comprising a process controller to monitor and modify said sonic energy supply and said microbial digestion.
51. An apparatus for sonication-enhanced degradation of cellular matter, said apparatus comprising:

a first bioreactor; and
a first sonic energy source operatively connected to said first bioreactor; said sonic energy source subjects cellular matter to sonic energy in a frequency range of about 1 kHz to about 10 kHz.

52. The apparatus of claim 51 further comprising at least one rotating member operatively connected to said first bioreactor.

53. The apparatus of claim 51 wherein said sonic energy source comprises a contact plate operatively connected to said first bioreactor, a transducer operatively connected to said contact plate, a wave-form generator operatively connected to said transducer and a power supply operatively connected to said transducer.

54. The apparatus of claim 51 further comprising a process controller to monitor and modify said sonic energy supply.

55. The apparatus of claim 51 further comprising a second bioreactor operatively connected to said first bioreactor.

56. The apparatus of claim 54 further comprising a second sonic energy source operatively connected to said second bioreactor; said second sonic energy source subjects cellular matter to sonic energy in a frequency range of about 1 kHz to about 2,000 kHz.

57. The apparatus of claim 55 wherein said second sonic energy source comprises a contact plate operatively connected to said second bioreactor, a transducer operatively connected to said contact plate, a wave-form generator operatively connected to said transducer and a power supply operatively connected to said transducer.

58. The apparatus of claim 53 further comprising at least one rotating member.

59. The apparatus of claim 55 further comprising a process controller.

60. The apparatus of claim 55 further comprising a third bioreactor operative connected to said second bioreactor.

61. A system for sonication-enhanced digestion of cellular matter, said system comprising:

a bioreactor for cellular matter;

means for sonically disrupting cellular matter contained in said bioreactor; and

means for mixing said cellular matter in said bioreactor;

wherein cellular matter is sonically disrupted, mixed, and digested in said bioreactor.